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From Strategy to Engagement: The Impact of the Scientific Approach on English Reading Performance in Indonesian Junior Secondary Schools

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Abstract

Grounded in constructivist and engagement theories, the scientific approach to language learning emphasizes observation, inquiry, and application as central processes that foster deep comprehension and active participation. Within the context of English language reading, this study sought to investigate the extent to which the scientific approach enhances students' reading comprehension and engagement. Employing a quasi-experimental design, the research involved an experimental group that received instruction through the scientific approach and a control group that received conventional instruction. Data was collected through pre- and post-tests, a structured engagement questionnaire, and semi-structured interviews, which were analyzed both quantitatively and qualitatively. The findings revealed that while the between-group differences were not statistically significant, students in the experimental group demonstrated notable improvements in reading comprehension scores, rising from a mean of 76.17 to 84.83. Moreover, nearly 70% of participants reported high to highest engagement, supported by qualitative evidence of increased motivation, active participation, and strategy use. These results underscore the pedagogical value of integrating scientific approach principles into English instruction to enhance comprehension and sustain learner engagement, though further large-scale and longitudinal studies are recommended.

Keywords: Scientific Approach, Reading Skills, Student Engagement, English Language Instruction

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INTRODUCTION

The Teaching English in junior secondary schools plays a pivotal role in developing students' foundational literacy, supporting their learning across subjects, and preparing them for further education. Reading competence, in particular, is a cornerstone of English instruction at this stage since it equips learners with the skills to access information, interpret meaning, and build the linguistic resources necessary for academic success (Lee et al., 2021; Schmitt et al., 2022). Strengthening reading comprehension among junior secondary English as a Foreign Language (EFL) learners is thus essential for ensuring their long-term academic growth and future readiness (McGeown et al., 2020).

Reading comprehension itself is a multidimensional construct that goes well beyond accurate decoding or word recognition. It requires vocabulary breadth, syntactic awareness, background knowledge, and the ability to strategically process and integrate information from texts (Schmitt et al., 2022; McGeown et al., 2020). Affective and motivational factors are equally important, as learners who are interested and engaged are more likely to persist with challenging tasks and deploy appropriate strategies (Lee et

al., 2021). This explains why traditional passive methods, such as rote memorization, translation, or teacher-centered lecturing, often produce limited improvements, particularly in sustaining students' comprehension of extended or authentic texts (Ali, 2022).

Indonesian junior secondary learners often face specific challenges, including limited exposure to English outside the classroom, insufficient vocabulary depth, and difficulty processing longer and more complex passages (Bachtiar & Puspitasari, 2024). Studies have also shown a mismatch between learners' needs and the instructional practices employed, with many curricula still relying heavily on conventional techniques and lacking strategy-focused activities (Bui, 2022; Ali, 2022). As a result, students are frequently underprepared to engage critically and independently with texts, underscoring the need for pedagogical models that explicitly foster comprehension strategies and motivation (Hyland & Jiang, 2021; Shirazi & Rahimi, 2023).

Student engagement is a key mediating factor between instruction and reading achievement. Engagement encompasses behavioural participation, cognitive investment in strategies, affective interest, and social interaction. Evidence demonstrates that effective instructional practices not only enhance engagement but also benefit directly from it, as engaged learners are more likely to apply strategies consistently and achieve deeper comprehension (Lee et al., 2021; Schmitt et al., 2022; McGeown et al., 2020). In this sense, engagement functions both as an antecedent and an outcome of successful reading instruction.

One promising framework to strengthen both comprehension and engagement is the "scientific" approach. Grounded in constructivist principles, this approach emphasizes systematic diagnosis, explicit strategy instruction, inquiry-based tasks, and iterative formative assessment (Cho et al., 2021; Shirazi & Rahimi, 2023). Rather than relying solely on teacher explanation, the scientific approach requires students to observe, question, analyze, and apply reading strategies, fostering active learning.

In particular, the value of explicit reading-comprehension strategy instruction has been extensively documented: it typically involves direct explanation, teacher modelling (think-alouds), guided practice, and gradual release toward independent application (Archer & Hughes, 2011; Sedita, 2020). Research shows that when teachers systematically scaffold students' use of strategies (e.g. summarizing, inference making, monitoring comprehension), reading comprehension improves significantly across grade levels (Elston, Tiba, & Condy, 2022; Geleta, Olana, & Ali, 2022). Further, explicit instruction is often considered an essential component of a truly scientific reading pedagogy, because it makes thinking visible, reduces cognitive load, and supports learners in gradually internalizing metacognitive routines (see "Science of Reading" frameworks) (Pressley & Afflerbach, 2020; Archer & Hughes, 2011).

Moreover, recent intervention studies in second-language contexts report that explicit reading strategy training yields measurable gains in comprehension outcomes (Dikkatli, 2023; Geleta et al., 2022). These results align with meta-analytic syntheses showing that multi-component, strategy-rich literacy programs outperform single-focus or purely didactic methods (Muhammadpour & Sabet, 2024; Cho et al., 2021). Blended or multimedia-supported designs grounded in this approach may further promote higher levels of motivation and participation (Shirazi & Rahimi, 2023).

Despite this theoretical and empirical promise, research on the scientific approach in Indonesian junior secondary English classrooms remains scarce. Existing studies often rely on small samples, narrow measures of engagement, or non-experimental designs, leaving questions about generalizability and sustainability unanswered (Bui, 2022; Ali, 2022; Schmitt et al., 2022). In particular, few investigations examine how engagement mediates the relationship between instructional strategies and reading comprehension

outcomes, a critical gap in understanding mechanisms of change (Lee et al., 2021; McGeown et al., 2020).

The present study addresses these gaps by comparing the effectiveness of the scientific approach with conventional instruction in Indonesian junior secondary English classes. Using a quasi-experimental design, it evaluates whether systematic, strategy-focused instruction leads to superior gains in reading comprehension and whether these gains are mediated by behavioural, cognitive, and affective engagement. Data are collected through pre- and post-tests, a validated multidimensional engagement questionnaire, and semi-structured interviews that capture students' perceptions and strategy reports. By integrating achievement outcomes with measures of engagement, this study provides context-specific evidence for improving reading pedagogy in Indonesian schools and contributes to the broader literature on how instructional design can enhance both comprehension and sustained learner participation (Hyland & Jiang, 2021; Muhammadpour & Sabet, 2024; Shirazi & Rahimi, 2023).

METHOD

Research Design

This study adopted a quasi-experimental design with a pre-test–post-test control group to investigate the effects of a scientific approach on ESP students' reading comprehension and engagement. The quasi-experimental design was chosen because it allows comparison between an intervention group and a control group while addressing the practical challenges of random assignment in authentic educational settings. Two intact classes of senior high school students were purposively assigned as the experimental and control groups to preserve ecological validity.

The experimental group received instruction through the scientific approach, characterized by systematic scaffolding, explicit reading strategy instruction, and iterative formative feedback, while the control group was taught using a conventional lecture-based approach. Both groups were taught by the same instructor to minimize teacher-related bias, and the intervention lasted for six meetings. This design was considered appropriate for examining causal relationships between instructional approach and learning outcomes, while controlling for contextual factors such as curriculum and instructional time.

Data Collection Procedure

Data were collected using multiple sources to ensure methodological triangulation. First, reading comprehension tests (pre- and post-tests) were administered to both groups. The tests were constructed from authentic English learning materials relevant to the students' classroom study. Reliability was established using Cronbach's alpha, yielding a coefficient above 0.80, indicating strong internal consistency.

Second, student engagement was measured using a multidimensional engagement scale, covering behavioural, cognitive, and affective dimensions. The instrument was adapted from validated engagement frameworks (Lee et. al., 2021) and adjusted to the English language high school context. The scale was administered before and after the intervention to capture changes in engagement levels.

Third, semi-structured interviews were conducted with six students from the experimental group. The six students were purposively selected to represent high, middle, and low achievers based on their test performance, ensuring diverse perspectives across achievement levels. The interviews explored students' perceptions of the scientific approach, their engagement during the program, and perceived challenges. All interviews were audio-recorded, transcribed verbatim, and member-checked to ensure credibility. All procedures adhered to ethical standards for educational research. Informed consent was obtained from all participants, confidentiality was maintained, and participation was voluntary.

Data Analysis

Quantitative data were analysed using descriptive and inferential statistics. Descriptive statistics (mean, standard deviation, and percentage) were used to summarize reading comprehension and engagement scores. Inferential statistics included paired-sample t-tests to measure within-group improvements from pre-test to post-test, and independent-sample t-tests to compare post-test performance between the experimental and control groups. The significance level was set at $p < .05$. Effect sizes (Cohen's *d*) were also calculated to determine the magnitude of differences (Field, 2018).

In addition, ANCOVA was employed to control for initial differences in pre-test scores, thereby providing a more robust estimation of the intervention's impact. Data analysis was conducted using JASP version 0.18, an open-source statistical software that provides advanced analysis options and effect size reporting.

Qualitative interview data were analysed thematically, following Braun and Clarke's (2021) six-step framework: (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. To ensure trustworthiness, triangulation was achieved by comparing quantitative and qualitative findings, while peer debriefing was conducted with two independent researchers in applied linguistics.

By integrating quantitative and qualitative analyses, the study adopted a mixed-methods perspective that not only measured statistical differences but also illuminated learners' subjective experiences with the scientific approach. This comprehensive methodology strengthens the validity of the findings and provides nuanced insights into both outcomes and processes of ESP instruction.

RESULT AND DISCUSSION

The following section presents and discusses the key findings of this study by integrating quantitative outcomes with qualitative insights. The analysis begins with the results of the pre-test and post-test, followed by the interpretation of questionnaire data and interview responses, to provide a comprehensive understanding of students' reading comprehension and engagement. By examining both statistical evidence and participants' perceptions, the results highlight not only the measurable impact of the scientific approach on ESP reading performance but also the ways in which learners experienced and responded to the intervention. This integration of multiple data sources allows for a nuanced discussion that situates the findings within existing literature and pedagogical practice

Scientific Approach Affects Students' Reading Comprehension

The results of this study revealed that the implementation of a scientific approach positively influenced English language students' reading comprehension achievement when compared to conventional lecture-based teaching. Table 1 provides the pre-test and post-test results.

Table 1. Pre-test and Post-test Results

		Pre-test treatment	Post-test treatment	Pre-test control	Post-test control
N	Valid	30	30	30	30
	Missing	30	30	30	30
	Mean	76.17	84.83	75.83	77.83
	Std. Error of Mean	3.42	3.24	4.91	4.16
	Std. Deviation	18.74	17.74	26.85	22.77

The descriptive statistics indicated an improvement in the treatment group, with mean scores increasing from 76.17 in the pre-test to 84.83 in the post-test. Although the

Mann–Whitney U test did not show a statistically significant difference between the treatment and control groups, the descriptive gains suggest that the scientific approach was beneficial in facilitating comprehension. These findings resonate with Ahmad et al. (2018) and Fathurrahman and Zainuddin (2020), who emphasized that the integration of scientific approaches leads to enhanced comprehension and engagement. Similarly, Rahmawati and Aisyah (2022) reported that such approaches not only foster comprehension but also strengthen critical thinking skills, which could account for the consistent improvement in the treatment group.

The findings of this study corroborate the previous study by Abdullah et al. (2019), which demonstrated that the use of structured, student-centred approaches significantly improved learners' comprehension outcomes. It is also in line with the study findings by Tang et al. (2021), who emphasized that integrating inquiry-based and contextual strategies fosters deeper engagement and ultimately supports better reading comprehension achievement. Similarly, Stefanova and Zabunov (2020) highlighted that when students are actively involved in observation, reasoning, and communication, their comprehension skills are positively reinforced. However, the present study contradicts the findings of Alzahrani and Althaqafi (2020), who reported statistically significant gains among EFL learners after employing explicit reading strategy instruction, suggesting that the effectiveness of the scientific approach may be more context-dependent. This divergence highlights the importance of situating scientific approaches within specific learning environments, student readiness, and instructional duration to maximize their impact.

The lack of statistical significance may be attributed to several contextual factors. As Chen and Cheng (2018) noted, the success of pedagogical interventions depends on their robustness and contextual alignment. In this study, limited exposure and relatively short intervention duration might have constrained the outcomes. Wanzek et al. (2013) further support this interpretation, showing that longer-term interventions yield more substantial gains in reading comprehension. These findings suggest that while the scientific approach offers promising potential, its effectiveness is contingent on sustained implementation and a more comprehensive alignment with learners' specific needs.

Insights from the interviews further reinforce the quantitative results, as many students expressed that the scientific approach encouraged them to be more curious, motivated, and confident in handling English reading tasks. Several participants emphasized that the structured phases of observing, questioning, and communicating helped them sustain focus and apply reading strategies more effectively, which echoes earlier findings by Abdullah et al. (2019) and Tang et al. (2021) on the benefits of inquiry-based learning in fostering engagement. Students also noted that the transfer of reading strategies to other English skills, such as writing and speaking, was particularly valuable, a perspective consistent with Stefanova and Zabunov (2020), who highlighted the role of active participation in building broader language competence. However, some participants pointed out difficulties in connecting classroom assessments with the learning process and in consistently identifying main ideas, which diverges from Alzahrani and Althaqafi (2020), who reported significant improvements when assessment was explicitly aligned with strategy instruction. These qualitative insights add depth to the statistical results, underscoring that while the scientific approach is effective in enhancing both cognitive and affective engagement, its impact can be maximized through closer alignment between instructional strategies and assessment practices.

Impact of the Scientific Approach on Student Engagement

In addition to comprehension outcomes, this study demonstrated that the scientific approach significantly enhanced student engagement in English reading activities. Table 2 presents the results of the engagement questionnaire.

Table 2. The Questionnaire Results on Engagement with the Scientific Approach

No.	Statement	SD	D	RA	A	SA
1	I actively participate in ESP reading tasks when my teacher uses the scientific approach (observing, questioning, trying, reasoning, communicating).	0	0	5	21	8
2	I feel encouraged to ask questions and seek clarification during ESP reading activities that use the scientific approach.	0	2	12	16	4
3	Collaborative activities (group work, peer discussion) embedded in the scientific approach help me understand the reading texts better.	0	0	10	18	6
4	The scientific approach improves my ability to identify the main ideas and key details in ESP texts.	0	3	13	16	2
5	I apply reading strategies (e.g., skimming, scanning, summarizing) more effectively when the scientific approach is used.	0	0	8	19	7
6	I plan and monitor my reading (set goals, check my understanding) more often when lessons follow the scientific approach.	0	0	11	16	7
7	My retention of important information from ESP texts is better when the scientific approach is applied.	0	0	9	20	5
8	Learning with the scientific approach increases my intrinsic motivation to read ESP materials.	0	0	4	18	12
9	I enjoy ESP reading lessons more when they use observation, inquiry, and communication (the scientific approach).	0	0	6	18	10
10	Using the scientific approach increases my confidence in tackling difficult ESP texts.	0	2	8	16	8
11	Instructions and tasks are clearer and easier to follow in lessons that use the scientific approach.	0	0	9	18	7
12	The assessments in this course reflect the skills and activities practiced during scientific approach lessons.	0	4	11	15	4
13	I sustain my attention and stay focused longer during reading activities that use the scientific approach.	0	1	9	17	7
14	The strategies and skills I learn through scientific approach activities can be applied successfully to other school subjects.	0	0	10	13	11

15	I can use the reading strategies learned through the scientific approach to improve other English skills (e.g., writing, speaking).	0	0	4	12	18
16	The scientific approach increases my curiosity and interest in the topics and texts we study.	0	0	3	22	9
17	The scientific approach prepares me better for future academic or professional reading tasks.	0	0	11	18	5
18	Overall, I am satisfied with my progress in reading comprehension because of participating in scientific approach activities.	0	1	9	15	9

Notes: SD (Strongly Disagree); D (Disagree); RA (Rather Agree); A (Agree); SA (Strongly Agree)

The results of the questionnaire reveal a consistently positive perception of the scientific approach among students, with most responses concentrated in the Agree and Strongly Agree categories across all items. Notably, items related to motivation, strategy use, and cross-subject application (e.g., Items 8, 14, 15, and 16) received some of the strongest endorsements, indicating that the scientific approach not only enhances comprehension but also fosters broader learning transfer and curiosity. Very few students selected 'Disagree' and no 'Strongly Disagree', which underscores the overall acceptance and effectiveness of the approach in promoting engagement in ESP reading. These findings suggest that the scientific approach successfully nurtures behavioral, cognitive, and emotional dimensions of engagement, though some variation in the strength of agreement across items points to opportunities for refining instructional design to maximize student satisfaction and learning outcomes.

While Table 2 provides an overview of the frequency distribution of students' responses, a more detailed examination of central tendency and variability is necessary to capture the intensity of their perceptions. Descriptive statistics, particularly the mean and standard deviation, offer deeper insights into how strongly students agreed with each statement and the extent to which their responses varied across items. Such analysis is crucial in highlighting not only the overall trends but also specific areas of strength and potential improvement in the implementation of the scientific approach. Accordingly, Table 3 presents the mean and standard deviation values for each questionnaire item to provide a more nuanced understanding of student engagement in English reading activities.

Table 3. Mean and Standard Deviation of the Questionnaire Results

No	Item	Mean	SD
1	I actively participate in ESP reading tasks when my teacher uses the scientific approach (observing, questioning, trying, reasoning, communicating).	3.28	0.45
2	I feel encouraged to ask questions and seek clarification during ESP reading activities that use the scientific approach.	3.09	0.53
3	Collaborative activities (group work, peer discussion) embedded in the scientific approach help me understand the reading texts better.	3.25	0.44
4	The scientific approach improves my ability to identify the main ideas and key details in ESP texts.	2.95	0.5
5	I apply reading strategies (e.g., skimming, scanning,	3.27	0.45

	summarizing) more effectively when the scientific approach is used.		
6	I plan and monitor my reading (set goals, check my understanding) more often when lessons follow the scientific approach.	3.27	0.45
7	My retention of important information from ESP texts is better when the scientific approach is applied.	3.2	0.41
8	Learning with the scientific approach increases my intrinsic motivation to read ESP materials.	3.36	0.49
9	I enjoy ESP reading lessons more when they use observation, inquiry, and communication (the scientific approach).	3.29	0.46
10	Using the scientific approach increases my confidence in tackling difficult ESP texts.	3.21	0.65
11	Instructions and tasks are clearer and easier to follow in lessons that use the scientific approach.	3.28	0.45
12	The assessments in this course reflect the skills and activities practiced during scientific approach lessons.	2.91	0.65
13	I sustain my attention and stay focused longer during reading activities that use the scientific approach.	3.21	0.55
14	The strategies and skills I learn through scientific approach activities can be applied successfully to other school subjects.	3.04	0.68
15	I can use the reading strategies learned through the scientific approach to improve other English skills (e.g., writing, speaking).	3.47	0.62
16	The scientific approach increases my curiosity and interest in the topics and texts we study.	3.33	0.56
17	The scientific approach prepares me better for future academic or professional reading tasks.	3.16	0.48
18	Overall, I am satisfied with my progress in reading comprehension as a result of participating in scientific approach activities.	3.27	0.63

The descriptive results in Table 3 demonstrate that students generally expressed positive engagement with the scientific approach in English reading, with item means ranging from 2.91 to 3.47 on a 4-point Likert scale. The highest endorsement was observed for the item "I can use the reading strategies learned through the scientific approach to improve other English skills" (M = 3.47, SD = 0.62), indicating strong perceived transferability of skills beyond reading. Similarly, items relating to intrinsic motivation (M = 3.36, SD = 0.49) and curiosity (M = 3.33, SD = 0.56) highlight the approach's ability to foster emotional engagement and sustained interest in English learning. Conversely, relatively lower means on items concerning assessment alignment (M = 2.91, SD = 0.65) and identifying main ideas (M = 2.95, SD = 0.50) suggest areas where instructional practices could be refined to maximize effectiveness. Overall, the consistency of means clustered around the "Agree" category, together with modest standard deviations, provides strong evidence that the scientific approach effectively supports both cognitive and affective dimensions of student engagement in English reading.

Table 4. The Category Students' Engagement

Level of Engagement	Frequency	Percent	Cumulative Percent
Moderate	12	34,29	34,29
High	13	37,14	71,43
Highest	10	28,57	100

Level of Engagement	Frequency	Percent	Cumulative Percent
Total	35	100	

Table 4 shows that students' engagement levels are predominantly positive, with nearly 70% of participants reporting either high or the highest engagement. This distribution highlights that while a substantial number of students are strongly committed to their learning, a considerable proportion (34.3%) remain at a moderate level, signaling room for improvement. The results suggest that current instructional strategies are largely effective in fostering engagement, yet targeted interventions may further elevate students from moderate to higher levels of engagement, ensuring more consistent and optimal participation across the cohort. Ultimately, the findings reinforce the importance of sustaining and enhancing engagement-oriented teaching practices to maximize academic outcomes.

The interview analysis identified four interrelated themes: enhanced engagement through diverse teaching strategies, increased motivation through practical applications, challenges in managing complex material, and positive reinforcement of comprehension through active participation.

First, students highlighted that diverse teaching strategies, such as clear explanations, guided reading, interactive discussions, and varied assessment methods, were instrumental in maintaining attention and fostering deeper understanding. Respondent A underscored the importance of clarity, while Respondents B and C emphasized interactive discussions and real-world applications as essential for engagement. These findings align with Abdullah et al. (2019), who demonstrated that student-centered, interactive approaches significantly enhance engagement. Likewise, Tang et al. (2021) stressed the value of contextualized, real-world applications in stimulating learner interest and motivation.

Second, the theme of increased motivation through practical applications underscores the motivational value of connecting theoretical knowledge to practice. Respondents noted that quizzes, collaborative projects, and real-world tasks heightened their willingness to engage with complex texts. These insights corroborate Rahman (2022), who found that active learning strategies, including problem-solving and group work, foster intrinsic motivation and persistence.

Third, students' reflections revealed challenges in managing complex material, ranging from difficulties with specialized vocabulary to struggles with dense texts. While some respondents relied on strategies such as repeated reading, others emphasized the need for structured guidance and additional resources. This theme highlights that even within an effective pedagogical framework, learners require differentiated scaffolding, a finding supported by Anwar et al. (2019), who observed that comprehension gains under scientific approaches may remain statistically modest without sufficient scaffolding or extended intervention.

Finally, the theme of positive reinforcement through active participation emerged as a critical factor in consolidating comprehension. Respondents described how active engagement in discussions, peer teaching, and collaborative analysis increased their confidence and reinforced understanding. This resonates with Stefanova and Zabunov (2020), who argue that active participation enhances both comprehension and self-efficacy, thereby contributing to sustained learning outcomes.

Synthesis and Implications

Taken together, the quantitative and qualitative findings suggest that the scientific approach provides meaningful benefits for ESP students, particularly in fostering engagement, motivation, and comprehension. While the lack of statistically significant differences indicates limitations in scope and duration, the thematic insights affirm that diverse, interactive, and practice-oriented methods can enhance students' learning

experiences. Importantly, these results are consistent with broader literature that emphasizes the need for sustained, contextually aligned interventions to achieve measurable gains (Alzahrani & Althaqafi, 2020; Sari & Utami, 2021).

Overall, this study contributes to ongoing debates about the role of the scientific approach in language education. Although its immediate statistical impact on reading comprehension achievement was inconclusive, its positive effects on engagement and motivation underscore its pedagogical value. Future research should therefore explore longitudinal designs, larger samples, and varied ESP contexts to more fully capture the transformative potential of scientific approaches in enhancing reading comprehension outcomes.

CONCLUSION

This study demonstrates that a structured scientific approach to English reading instruction can meaningfully enhance students' comprehension and engagement. While inferential analyses did not yield statistically significant between-group differences, the descriptive results showed a notable rise in the treatment group's mean scores, from 76.17 in the pre-test to 84.83 in the post-test, reflecting substantial performance gains. These improvements were reinforced by strong instrument reliability and convergent qualitative evidence, including students' reports of increased motivation, active participation, and effective strategy use. Nearly 70% of learners also indicated high to very high engagement, suggesting that the approach fostered not only cognitive growth but also the affective and motivational conditions necessary for sustained comprehension. The findings, therefore, underscore the pedagogical value of embedding scientific principles into reading instruction, as they support both strategic reading processes and learner engagement even when short-term statistical contrasts remain inconclusive. At the same time, variability in student satisfaction and perceived progress points to the moderating influence of factors such as learner readiness, implementation fidelity, and instructional intensity, highlighting important considerations for future research and classroom application.

Practically, the findings imply that curriculum designers and instructors should integrate multi-component, evidence-based sequences, explicit strategy instruction, scaffolded practice, formative feedback, and authentic ESP materials to strengthen both comprehension and engagement. Teacher professional development must emphasize careful adaptation of tasks to students' prior knowledge and systematic monitoring of fidelity to reduce variability in outcomes. For research, the study highlights the need for larger, longitudinal, and randomized trials that incorporate objective achievement measures, fidelity checks, and moderator analyses (e.g., prior proficiency, intervention length) to clarify causal mechanisms. Key limitations to acknowledge are the quasi-experimental design, relatively short intervention period, modest sample size, and partial reliance on self-report engagement measures, all of which constrain statistical power and generalizability. Addressing these limitations in future work will be essential to confirm the promising patterns observed here and to translate them into durable, scalable ESP interventions.

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